ELECTRO-HYDRAULIC ACTUATOR
CONTROL SYSTEM

POWER & CONTROL FOR
DOUBLE ACTING OR SPRING RETURN
HYDRAULIC ACTUATORS
SERIES M-91
U.S. Patent # 5,097,857

ELECTRIC ACTUATION USING...

Standard Hydraulic Actuators

♦ Same unit suitable for all types of hydraulic actuators.

♦ Custom designed systems available.

♦ Variable torque or thrust by adjusting output pressure.

♦ Variable speed for both “Open” & “Close” via standard flow control valves.

♦ Power and control for quarter-turn or linear actuators.

♦ 100-psig minimum hydraulic output to 3,000-psig maximum hydraulic output.

♦ Standard industrial components with interchangeable parts.

♦ Electric “Fail Safe” using spring return actuators or hydraulic accumulators with double acting actuators.

♦ Suitable for 4-20 mAdc modulating service.

♦ Suitable for use with multiple actuators.
Cyprus Mineral

**Electro-Hydraulic Unit**

**Solar-Powered**

These M-91’s are being used to open and close 30” valves in a remote area. Solar power with a battery backup system is the only source of power available on this application. These units are delivering 2 GPM @ 2,500-pisg.

---

DuPont Company
Richmond, VA

Jefferson Davis Highway Plant

**Electro-Hydraulic Power Unit**

This M-91 controls the main extruding valve in a production line. This customer was very concerned with overall design and quality because of the critical nature of the application.
Hydraulic Modulating Control

4-20mAdc Input Signal

This M-91 is modulating three (3) 12” valves via PLC inputs from an O₂ transmitter at a remote location. It is also providing “Fail Safe” operation through the use of a high-pressure hydraulic accumulator system. These valves are capturing vented methane gas from coal mining operations. It is then sold for a profit instead of being vented to the atmosphere. OXY has purchased over thirty (30) units on this project so far.

ASARCO COPPER

ELECTRO-HYDRAULIC

This M-91 is being used on a copper tailings line with a 24” 300 # gate valve. Electric “Fail Safe” via a high-pressure hydraulic accumulator system is also used here.
High-pressure hydraulic piston-type accumulators were used to store hydraulic energy for opening and closing the actuators after a power failure. Extra room was left in the control cabinet for a customer-supplied PLC. A complete documentation package was supplied for the system, which included a bill of materials, electrical schematics, hydraulic schematics, panel layouts, operating and maintenance instructions and copies of component manufacturer’s catalog cut sheets.
## Series M-91

### Electro-Hydraulic Actuator Control System

U.S. Patent # 5,097,857

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
</table>
♦ Outdoor applications.  
♦ Epoxy paint topcoat over factory zinc phosphate primer for corrosion resistance. |
| **Cabinet Heater & Thermostat**, (Optional) | ♦ Reduces condensation inside enclosure.  
♦ Helps to maintain fluid viscosity. |
| **Electric “Fail Safe”, configurable.** | ♦ Suitable for “Fail Safe” applications with any spring return hydraulic actuator or with any double acting hydraulic actuator using an accumulator system. |
| **System Pressure Gauges** | ♦ Visual confirmation of overall system operating pressure driving the actuator.  
♦ Confirmation of “High/Low” (Pump On / Pump Off) pressure switch settings. |
| **100% Continuous Duty Cycle** pump and TEFC motor (120-vac / 1 Ph / 60 Hz). | ♦ Designed for demanding industrial applications. |
| **Variable Actuator Speed & Torque** or (Thrust). | ♦ Suitable for wide range of actuators.  
♦ Permits “fine tuning” for customer’s application.  
♦ Helps to eliminate any “water hammer” problems. |
| **“Local / Remote”** selector switch. | ♦ Permits manual override and jogging of actuator from M-91 control panel.  
♦ Easier and safer maintenance and calibration procedures. |
| **“Open & Close”** pilot lights and pushbuttons. | ♦ Allows confirmation of valve/actuator position while at the M-91 control panel.  
♦ Safer and surer maintenance and calibration procedures. |
<p>| <strong>Circuit Breaker</strong> | ♦ “Electrical Isolation” of M-91 for installation, maintenance and calibration. |
| <strong>Automatic Bypass Relief valve</strong> | ♦ Prevents “over pressure” of actuator and system components. |</p>
<table>
<thead>
<tr>
<th><strong>System Timer</strong></th>
<th>♦ Prevents the system from running indefinitely and damaging the pump in case of a hydraulic leak or line rupture.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emergency Stop</strong> palm button.</td>
<td>♦ “One touch” safety shutdown of system (requires manual reset of E-Stop pushbutton).</td>
</tr>
</tbody>
</table>
| **Diagnostic “LED” light array.** | ♦ System status available at a glance.  
  ♦ Enhanced safety and troubleshooting during maintenance operations. |
| **Auxiliary “Dry contacts”** for remote “Open” and “Closed” indication in control room. (Driven by customer-supplied limit switches). | ♦ Provides a new set of dry limit switch contacts for remote applications.  
  ♦ Provides easy and electrically safe connections to PLC for automated and remote operations. |
| **Field selectable failure modes** not only for spring return actuators, but also for double acting actuators. | ♦ Prevents the motor from running on the “spring stroke” of a spring return actuator. |
| **Standard industry-common components.** | ♦ Easy replacement of components.  
  ♦ Not “locked in” to manufacturer for costly proprietary components.  
  ♦ Enhanced system “up time”. |
| **Legend plates and labeling** of all critical system components. | ♦ Enhanced operator safety.  
  ♦ Easy maintenance identification and troubleshooting. |
| **Wide variety of optional, special and custom configurations.** | ♦ Broad application suitability.  
  ♦ Relatively quick lead times on specials. |
| **100% Bench testing and calibration prior to shipment.** | ♦ Quality assurance.  
  ♦ Documentation of operating performance at the time of shipment. |
| **Tank level switch.** | ♦ Shuts down system in case of a “low oil” condition.  
  ♦ Prevents pump “starvation” and damage. |
| **10-Micron return oil filtration system with gauge.** | ♦ Protects and enhances pump life.  
  ♦ Enhances system “up time”. |
| **Insensitive to vibrations.** | ♦ Can be installed in difficult environments. |

**Virginia Valve Company Corporation**

**Automation Division**

1390-C Southside Drive  
Salem, Virginia 24153-4604

Web Site:  www.actuatorsvalves.com  
E-Mail:  vavalve@rbnet.com

U. S. Toll Free Ph #:  888-389-0364  
Ph #:  540-389-0364  
Fax #:  540-389-0494
Electro-Hydraulic Actuator Control System:

Suggested Engineering Specification:

The system shall be equipped with the following provisions, which will permit the operation of a hydraulic actuator both in a “Local” mode and in a “Remote” mode given only a 120-vac power source:

A.) The unit shall be housed in a NEMA 4 carbon steel enclosure finish painted with PPG Aquapon polyamide epoxy corrosion resistant paint. It will be suitable for either wall mounting away from the valve/actuator assembly or it can be mounted on an optional heavy-duty epoxy painted carbon steel freestanding floor stand.

B.) The unit will have an “Emergency Stop” palm button which, when pushed, will shut down the entire system (manual reset required).

C.) The unit will have a “Remote / Local” selector switch which permits operation of the actuator either manually or remotely via control input signals.

D.) The unit will have an “Open / Stop / Close” selector switch which is active only when the “Local” switch is on. It will permit stroking the actuator from the control panel.

E.) The unit will have an enclosure heater and thermostat for condensation/moisture management.

F.) The unit will have a diagnostic “LED” light array. The six (6) standard lights are: “Breaker On”, “Power On”, “Remote”, “Open”, “Closed” and “E-Stop Engaged”.

G.) The unit will be suitable for 120-vac / 1 Ph / 60 Hz input power (standard). It will include a terminal strip and legend plate for field wiring connections. Further, it will include a circuit breaker and motor starter properly sized to the pump/motor combination.

H.) The unit will include two (2) flow control valves, which will permit “fine tuning” of the opening and closing actuator speeds.

I.) The unit will include two (2) hydraulic bulkhead connections (valve “Open” and valve “Close”) on the side of the enclosure.

J.) The unit will include a 100% duty cycle TEFC motor sized with a gear pump to deliver the required flow at the required pressure.

K.) The unit will be capable of operating both quarter-turn and linear actuators.

L.) The unit will be designed to provide system operating pressures up to 3,000-psig.

M.) The unit will have adjustable pressure switches, which determine when the pump/motor will turn on and off. Thereby providing a reliable range of system operating pressure for actuator sizing.

N.) The unit will have a reservoir “Low Oil” level switch, which will shut the system down prior to pump starvation and damage. Further, the reservoir will have a sight level/temperature gauge and reservoir drain valve.

O.) The unit will have an adjustable timer to provide a shutdown of the system to prevent the pump/motor from running indefinitely.

P.) The unit will have an adjustable bypass relief valve to control the maximum system pressure possible.

Q.) The unit will have isolated “dry contact” outputs available for end-of-stroke indication from customer-supplied limit switches.

R.) The unit can be configured for use in modulating service (accumulator system required).

The Electro-Hydraulic Actuator Control System shall be Model # M-91- (see Model # Detail) as manufactured by Virginia Valve Co. Corp., 1390-C Southside Dr., Salem, VA 24153-4604.

U.S. Toll Free Ph. #: 888-389-0364 / Ph #: 540-389-0364
Fax #: 540-389-0494
E-Mail: vavalve@rbnet.com.
**Series M-91**

**Electro-Hydraulic Actuator Control System**

**Technical Specifications**

<table>
<thead>
<tr>
<th>Enclosure: NEMA 4 carbon steel (zinc phosphate factory primer with finish top coat of PPG Aquapon polyamide epoxy corrosion resistant paint). NEMA 4X stainless steel and non-metallic are optionally available. Size will vary depending upon overall system requirements and customer specification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Required: 120-vac / 1 Ph / 60 Hz (Standard).</td>
</tr>
<tr>
<td>Circuit Breaker: Sized to pump and motor requirements.</td>
</tr>
<tr>
<td>Motor: 100% continuous duty cycle, TEFC.</td>
</tr>
<tr>
<td>Pump: Fixed displacement steel gear pump (Standard). Flow rates from 0.5 – 3.5 GPM.</td>
</tr>
<tr>
<td>Bypass Relief: Adjustable to system operating requirements.</td>
</tr>
<tr>
<td>Pressure Settings: Variable 100 – 3,000-psig.</td>
</tr>
<tr>
<td>Pressure Switches: Adjustable to system operating requirements.</td>
</tr>
<tr>
<td>Oil Filtration: 10-Micron Spin-on type return oil.</td>
</tr>
<tr>
<td>Pressure Gauges: 2.5” glycerine-filled 0 – 3,000-psig.</td>
</tr>
<tr>
<td>System Timer: Adjustable to system operating requirements.</td>
</tr>
<tr>
<td>Tank Level Switch: SPDT (single pole double throw).</td>
</tr>
<tr>
<td>Operating Modes: “Remote” / “Local”.</td>
</tr>
<tr>
<td>Weight: Varies depending upon overall system configuration (dry).</td>
</tr>
</tbody>
</table>
**Standard M-91 Operating Range of Applications**

**H.P. Required to Produce GPM Flow @ A Given Pressure**
(For higher G.P.M. flows and pressures, contact factory for pricing and availability)

<table>
<thead>
<tr>
<th>Flow Rate (GPM)</th>
<th>500</th>
<th>750</th>
<th>1,000</th>
<th>1,250</th>
<th>1,500</th>
<th>1,750</th>
<th>2,000</th>
<th>2,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.17</td>
<td>0.26</td>
<td>0.34</td>
<td>0.43</td>
<td>0.52</td>
<td>0.60</td>
<td>0.69</td>
<td>0.86</td>
</tr>
<tr>
<td>1.0</td>
<td>0.34</td>
<td>0.52</td>
<td>0.69</td>
<td>0.86</td>
<td>1.03</td>
<td>1.20</td>
<td>1.37</td>
<td>1.72</td>
</tr>
<tr>
<td>1.5</td>
<td>0.52</td>
<td>0.77</td>
<td>1.03</td>
<td>1.29</td>
<td>1.54</td>
<td>1.80</td>
<td>2.06</td>
<td>2.57</td>
</tr>
<tr>
<td>2.0</td>
<td>0.69</td>
<td>1.03</td>
<td>1.37</td>
<td>1.72</td>
<td>2.06</td>
<td>2.40</td>
<td>2.75</td>
<td>3.43</td>
</tr>
<tr>
<td>2.5</td>
<td>0.86</td>
<td>1.29</td>
<td>1.72</td>
<td>2.14</td>
<td>2.57</td>
<td>3.00</td>
<td>3.43</td>
<td>4.29</td>
</tr>
<tr>
<td>3.0</td>
<td>1.03</td>
<td>1.54</td>
<td>2.06</td>
<td>2.57</td>
<td>3.09</td>
<td>3.60</td>
<td>4.12</td>
<td>5.15</td>
</tr>
<tr>
<td>3.5</td>
<td>1.20</td>
<td>1.80</td>
<td>2.40</td>
<td>3.00</td>
<td>3.60</td>
<td>4.20</td>
<td>4.80</td>
<td>6.00</td>
</tr>
</tbody>
</table>

**NOTE:** Formula = HP = pressure x flow
(1,714) x (0.85)

**NOTE:** Accumulators can be used to increase system G.P.M. discharge capacity without increasing the horsepower (HP) requirement (depending upon the recovery time required between operating cycles).
Information Required To Correctly Size And Order A
Series M-91 Electro-Hydraulic Actuator Control System:

1.) How many actuator workstations are required? ____________________________.

2.) What is the desired **maximum** system operating pressure range? _______ Psig.

3.) What type of electrical enclosure is needed? NEMA

4.) What electrical input power available? _____ vac / _____ Ph / _____ Hz ______ amps

5.) Is a “Fail Safe” system required? Yes_____ / No
   
   If “Yes”, A.) Accumulator: Yes_____ / No_____ Required recovery time?
   
   B.) Spring Return Actuator: Yes_____ / No

6.) Who is to furnish this system?

7.) Is modulation of the actuator required? Yes_____ / No

   Note: Accumulator system **must** be used with this service.

   If “Yes” what is the command input signal?

8.) Is remote operation capability required? Yes_____ / No

9.) Is a freestanding floor stand required for the M-91 enclosure? Yes_____ / No

10.) What is the volumetric displacement of the actuator? _______________ Cubic inches

11.) What is the designed **maximum** pressure rating of the actuator? _______________ psig

12.) What is **minimum** pressure the actuator was sized for? _______________ psig

13.) How often will the actuator operate?

14.) What is the desired actuator stroking speed? Maximum_________ Minimum

15.) What is the **minimum** required thrust or torque to operate the valve?

16.) What are the ambient temperatures of the environment where this system will be

   operating? **Maximum** _________ 0°F / 0°C **Minimum** _________ 0°F / 0°C
<table>
<thead>
<tr>
<th>Base Model #</th>
<th># Of Work Stations</th>
<th>Max. Hyd. Press. (psig)</th>
<th>Encl. Type</th>
<th>Encl. Size h x w x d</th>
<th>Input Power Vac/Ph/Hz</th>
<th>Fail Safe System/ Furn. By:</th>
<th>Modulate Position</th>
<th>Select. Switch For Local/ Remot e</th>
<th>Floor Stand</th>
<th>Encl. Heater</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-91</td>
<td>1= 1 Sta.</td>
<td>A=100-400</td>
<td>1=NEMA 4 epoxy painted steel</td>
<td>A=30x24x16</td>
<td>A=120/240/1/60</td>
<td>1=None</td>
<td>A=None</td>
<td>1= Yes</td>
<td>A= Yes</td>
<td>A= Yes</td>
</tr>
<tr>
<td></td>
<td>2= 2 Sta.</td>
<td>B=400-1000</td>
<td>2=NEMA 4X SS</td>
<td>B=36x30x16</td>
<td>B=220/440/3/60</td>
<td>2=Accum.</td>
<td>B1=4-20 mAdc input Sig.</td>
<td>2= No</td>
<td>B= No</td>
<td>B= No</td>
</tr>
<tr>
<td></td>
<td>3= 3 Sta.</td>
<td>C=1,000-2,000</td>
<td>3=Spec. C=36x36x20</td>
<td>C=Spec.</td>
<td></td>
<td>3=Spring Ret. Act.</td>
<td>B2=4-20 mAdc input Sig.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4= 4 Sta.</td>
<td>D=2,000-2,500</td>
<td>4=NEMA 4X Non-met. D=Spec.</td>
<td></td>
<td></td>
<td>4=Spec.</td>
<td>B3=3-15 psig input Sig.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F=&gt;3,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1=VA Valve</td>
<td>2=Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3=N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sample Model #**

M-91 1 D 1 B A 1/3 A 1 A A

**AVAILABLE OPTIONS:**

- Separate Local Station w/ pushbuttons for each actuator workstation (in addition to the workstation mounted on the door of the M-91).
- Hydraulic hose (pressure rated for the application). Includes appropriate fittings for connection to the M-91 bulkheads and to the actuator. Please specify length required. Quick-disconnect type fittings are also available as an option.
- High-pressure oil filtration system.
- Flow control valves: “sandwich” type or “in-line” type.
- Pressure reducing valve.
- Hydraulic oil cooling system.
- Reservoir immersion-type heater.
- 0-1,000 ohm valve stem position feedback signal (for ¼-turn modulating applications).
- 4-20 mAdc valve stem position feedback signal (for ¼-turn and linear modulating applications) (includes loop power supply and ground loop isolator).
- Electrical interlock w/ defeater for enclosure door.

**NOTE:** Accumulator must be used with modulating applications.

**NOTE:** Consult factory for lead times.